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What is claimed is:

1           1. A rewritable optical recording medium comprising  
2 a substrate having a wobble groove, and a phase-change  
3 recording layer, wherein a crystal state of the recording  
4 layer is an unrecorded or erased state and an amorphous state  
5 of the recording layer is a recorded state, and amorphous  
6 marks corresponding to the recorded state are formed by  
7 recording light,

8           after an EFM-modulated signal is recorded by an  
9 overwriting operation ten times in the recording layer at  
10 an the 8-times velocity  $V$  as high as eight times of a  
11 reference velocity (1-times velocity)  $V_1$ , which is a linear  
12 velocity of 1.2 m/s, with a data reference clock period  $T$   
13 retained so as to satisfy  $VT=V_1T_1$  (where  $T_1$  is 231 ns) under  
14 one selected from various conditions of the following  
15 recording method 1:

16           a modulation  $m_{11}$  of an eye pattern of the recorded  
17 signal obtained as retrieved at the 1-times velocity is  
18 60-80%,

19           a topmost level  $R_{top}$  of reflectivity of the eye pattern  
20 of the recorded signal obtained as retrieved at the 1-times  
21 velocity is 15-25%, and

22           a jitter of the individual length of marks and  
23 inter-marks obtained as retrieved at the 1-times velocity  
24 are equal to or less than 35 ns; and

25           said recording method 1 is carried out by exposing the

26 recording layer to recording light of a 780 nm wavelength  
27 via an optical system whose numerical aperture (NA) is 0.55  
28 or 0.5, with the time length of the individual amorphous  
29 mark being  $nT$  ( $n$  is an integer within a range of from 3 through  
30 11), in the following manner:

31 during that time, erasure power  $P_e$ , which is able to  
32 crystallize the individual amorphous-state portions,  
33 irradiates inter-mark portions between the individual  
34 recorded marks,

35 for the recorded marks, the time length  $(n-j)T$  is  
36 divided into  $\alpha_1T, \beta_1T, \alpha_2T, \beta_2T, \dots, \alpha_mT, \beta_mT$  (where  $m=n-1$ ,  
37  $\alpha_1=1.0, \alpha_i=0.5$  ( $i$  is an integer selected from 2 through  
38  $m$ ),  $\beta_m=$  from 0.25 to 0.75,  $\alpha_i+\beta_{i-1}=1.0$  ( $i$  is an integer within  
39 a range of from 2 to  $m$ )) in this sequence so as to satisfy  
40  $\sum_i(\alpha_i+\beta_i)=n-j$  ( $j$  is a real number within a range of from 0  
41 to 2.0),

42 within the time length  $\alpha_iT$  ( $i$  is an integer within a  
43 range from 1 to  $m$ ), the recording light, whose record power  
44  $P_w$  is enough to melt said recording layer, irradiates the  
45 recording layer (where  $P_w$  is 14 to 25 mW and  $P_e/P_w=0.5$ ),  
46 and

47 within the time length  $\beta_iT$  ( $i$  is an integer within a  
48 range of from 1 to  $m$ ), the recording light of bias power  
49  $P_b$  of 0.8 mW irradiates to the recording layer.

1 2. A rewritable optical recording medium comprising  
2 a substrate having a wobble groove, and a phase-change

3 recording layer, wherein a crystal state of the recording  
4 layer is an unrecorded or erased state and an amorphous state  
5 of the recording layer is a recorded state, and amorphous  
6 marks corresponding to the recorded state are formed by  
7 recording light

8 after an EFM-modulated signal is recorded by an  
9 overwriting operation ten times in the recording layer at  
10 a 10-times velocity  $V$  as high as 10 times of a reference  
11 velocity (1-times velocity)  $V_1$ , which is a linear velocity  
12 of 1.2 m/s, with a data reference clock period  $T$  retained  
13 so as to satisfy  $VT=V_1T_1$  (where  $T_1$  is 231 ns) under one  
14 selected from various conditions of the following recording  
15 method 1',

16 a modulation  $m_{11}$  of an eye pattern of the recorded  
17 signal obtained as retrieved at the 1-times velocity is  
18 60-80%,

19 a topmost level  $R_{top}$  of reflectivity of the eye pattern  
20 of the recorded signal obtained as retrieved at the 1-times  
21 velocity is 15-25%, and

22 a jitter of the individual length of amorphous marks  
23 and inter-marks obtained as retrieved at the 1-times  
24 velocity are equal to or less than 35 ns; and

25 said recording method 1' is carried out by exposing  
26 the recording layer to recording light of a 780 nm wavelength  
27 via an optical system whose numerical aperture (NA) is 0.55  
28 or 0.5, with the time length of the individual amorphous  
29 mark being  $nT$  ( $n$  is an integer within a range of from 3 to

30 11), in the following manner:

31 during that time, erasure power  $P_e$ , which is able to  
32 crystallize the individual amorphous-state portions,  
33 irradiates inter-mark portions between the individual  
34 recorded marks,

35 for the recorded marks, the time length  $(n-j)T$  is  
36 divided into  $\alpha_1T, \beta_1T, \alpha_2T, \beta_2T, \dots, \alpha_mT, \beta_mT$  (where  $m=n-$   
37  $1, \alpha_1=1.0, \alpha_i=0.5$  ( $i$  is an integer within a range of from  
38  $2$  to  $m$ ),  $\beta_m=$  from  $0.25$  to  $0.75, \alpha_i+\beta_{i-1}=1.0$  ( $i$  is an integer  
39 within a range of from  $2$  to  $m$ )) in this sequence so as to  
40 satisfy  $\sum_1(\alpha_i+\beta_i)=n-j$  ( $j$  is a real number within a range of  
41 from  $0$  to  $2.0$ ),

42 within the time length  $\alpha_iT$  ( $i$  is an integer within a  
43 range of from  $1$  to  $m$ ), the recording light, whose record  
44 power  $P_w$  is enough to melt said recording layer, irradiates  
45 the recording layer (where  $P_w$  is  $14$  to  $25$  mW and  $P_e/P_w=0.5$ ),  
46 and

47 within the time length  $\beta_iT$  ( $i$  is an integer within  
48 a range of from  $1$  to  $m$ ), the recording light of bias power  
49  $P_b$  of  $0.8$  mW irradiates the recording layer.

1 3. A rewritable optical recording medium according  
2 to claim 1 or 2, wherein

3 after an EFM-modulated signal is recorded by an  
4 overwriting operation ten times in the recording layer at  
5 a 4-times velocity  $V$  as high as 4 times of a reference  
6 velocity (1-times velocity)  $V_1$ , which is a linear velocity

7 of 1.2 m/s, with a data reference clock period  $T$  retained  
8 so as to satisfy  $VT=V_1T_1$  (where  $T_1$  is 231 ns) under one  
9 selected from various conditions of the following recording  
10 method 2,

11 a modulation  $m_{11}$  of an eye pattern of the recorded  
12 signal obtained as retrieved at the 1-times velocity is  
13 60-80%,

14 a topmost level  $R_{top}$  of reflectivity of the eye pattern  
15 of the recorded signal obtained as retrieved at the 1-times  
16 velocity is 15-25%, and

17 a jitter of the individual amorphous marks and  
18 inter-marks obtained as retrieved at the 1-times velocity  
19 are equal to or less than 35 ns;

20 said recording method 2 is carried out by exposing the  
21 recording layer to recording light of a 780 nm wavelength  
22 via an optical system whose numerical aperture (NA) is 0.55  
23 or 0.5, with the time length of the individual amorphous  
24 mark being  $nT$  ( $n$  is an integer within a range of from 3 to  
25 11), in the following manner:

26 during that time, erasure power  $P_e$ , which is able to  
27 crystallize the individual amorphous-state portions,  
28 irradiates inter-mark portions between the individual  
29 recorded marks,

30 for the recorded marks, the time length  $(n-j)T$  is  
31 divided into  $\alpha_1T, \beta_1T, \alpha_2T, \beta_2T, \dots, \alpha_mT, \beta_mT$  (where  $m=n-$   
32  $1, \alpha_1=1.0, \alpha_i$  = from 0.3 to 0.6 ( $i$  is an integer within a range  
33 of from 2 to  $m$ ),  $\beta_m$  = from 0.25 to 0.75,  $\alpha_i+\beta_{i-1}=1.0$  ( $i$  is an

34 integer within a range of from 2 to m)) in this sequence  
35 so as to satisfy  $\sum_1(\alpha_1+\beta_1)=n-j$  (j is a real number within  
36 a range of from 0 to 2.0),

37 within the time length  $\alpha_1 T$  (i is an integer within a  
38 range of from 1 to m), the recording light, whose record  
39 power  $P_w$  is enough to melt said recording layer, irradiates  
40 the recording layer (where  $P_w$  is 14 to 25 mW and  $P_e/P_w=0.5$ ),  
41 and

42 within the time length  $\beta_1 T$  (i is an integer within a  
43 range of from 1 to m), the recording light of bias power  
44  $P_b$  of 0.8 mW irradiates the recording layer.

1 4. A rewritable optical recording medium according  
2 to claim 1 or 2, wherein

3 after an EFM-modulated signal is recorded by an  
4 overwriting operation ten times in the recording layer at  
5 a 4-times velocity  $V$  as high as 4 times of a reference  
6 velocity (1-times velocity)  $V_1$ , which is a linear velocity  
7 of 1.2 m/s, with a data reference clock period  $T$  retained  
8 so as to satisfy  $VT=V_1 T_1$  (where  $T_1$  is 231 ns) under one  
9 selected from various conditions of the following recording  
10 method 3,

11 a modulation  $m_{11}$  of an eye pattern of the recorded  
12 signal obtained as retrieved at the 1-times velocity is  
13 60-80%,

14 a topmost level  $R_{top}$  of reflectivity of the eye pattern  
15 of the recorded signal obtained as retrieved at the 1-times

16 velocity is 15-25%, and

17 a jitter of the individual amorphous marks and  
18 inter-marks obtained as retrieved at the 1-times velocity  
19 are equal to or less than 35 ns;

20 said recording method 3 is carried out by exposing the  
21 recording layer to recording light of a 780 nm wavelength  
22 via an optical system whose numerical aperture (NA) is 0.55  
23 or 0.5, with the time length of the individual amorphous  
24 mark being  $nT$  ( $n$  is an integer within a range of from 3 to  
25 11), in the following manner:

26 during that time, erasure power  $P_e$ , which is able to  
27 crystallize the individual amorphous-state portions,  
28 irradiates inter-mark portions between the individual  
29 recorded marks,

30 for the recorded marks, the time length  $(n-j)T$  is  
31 divided into  $\alpha_1T, \beta_1T, \alpha_2T, \beta_2T, \dots, \alpha_mT, \beta_mT$  (where  $m=n-1$ ,  
32  $\alpha_1=0.4$ ,  $\alpha_i$  = from 0.15 to 0.25 ( $i$  is an integer within a  
33 range of from 2 to  $m$ ),  $\beta_m$  = from 0.25 to 0.75,  $\alpha_i+\beta_{i-1}=1.0$  ( $i$   
34 is an integer within a range of from 2 to  $m$ )) in this sequence  
35 so as to satisfy  $\sum_i(\alpha_i+\beta_i)=n-j$  ( $j$  is a real number within  
36 a range of from 0 to 2.0),

37 within the time length  $\alpha_iT$  ( $i$  is an integer within a  
38 range of from 1 to  $m$ ), the recording light, whose record  
39 power  $P_w$  is enough to melt said recording layer, irradiates  
40 the recording layer (where  $P_w$  is 14 to 25 mW and  $P_e/P_w=0.5$ ),  
41 and

42 within the time length  $\beta_iT$  ( $i$  is an integer within a



43 range of from 1 to m), the recording light of bias power  
44 Pb of 0.8 mW irradiates the recording layer.

1 5. A rewritable optical recording medium according  
2 to claim 1 or 2, wherein said phase-change recording layer  
3 comprises an alloy composition containing an excessive  
4 amount of Sb as compared to a eutectic composition of SbTe.

1 6. A rewritable optical recording medium according  
2 to claim 1 or 2, wherein said modulation  $m_{11}$  retains 90% or  
3 more of its initial value after the lapse of 500 hours under  
4 an acceleration test environment of a temperature of 80°  
5 C and a relative humidity of 85%.

1 7. A rewritable optical recording medium according  
2 to claim 1 or 2, wherein said recording medium includes,  
3 on the wobble-grooved substrate, a lower protective layer,  
4 a phase-change recording layer, an upper protective layer,  
5 and a reflective layer, said phase-change recording layer  
6 comprising one selected from the compositions represented  
7 by  $M_zGe_y(Sb_xTe_{1-x})_{1-y-z}$  (where  $0 \leq z \leq 0.1$ ,  $0 < y \leq 0.1$ ,  $0.72 \leq x \leq$   
8  $0.8$ , and M is at least one element selected from the group  
9 consisting of In, Ga, Si, Sn, Pb, Pd, Pt, Zn, Au, Ag, Zr,  
10 Hf, V, Nb, Ta, Cr, Co, Bi, O, N, S and rare earth metal  
11 elements).

1 8. A rewritable optical recording medium according

2 to claim 7, wherein a crystal phase of the crystal state  
3 comprises a single-phase or a multi-phase structure having  
4 a face-centered cubic structure.

1 9. A rewritable optical recording medium according  
2 to claim 1, wherein in the recording at the 8-times velocity,  
3 after a single-period signal composed of a 3T mark  
4 (having a time length of 3T where T is a data reference clock  
5 period), and a 3T space portion (inter-mark portion having  
6 a time length of 3T) is recorded,  
7 another single-period signal composed of an 11T mark  
8 (having a time length of 11T) and an 11T space portion  
9 (inter-mark portion having a time length of 11T) is  
10 overwritten in such a manner that the 3T mark is erased at  
11 an erase ratio of 25 dB or higher.

1 10. A rewritable optical recording medium according  
2 to claim 2, wherein in the recording at the 1the 2-times  
3 velocity,  
4 after a single-period signal composed of a 3T mark  
5 (having a time length of 3T where T is a data reference clock  
6 period), and a 3T space portion (inter-mark portion having  
7 a time length of 3T) is recorded,  
8 another single-period signal composed of an 11T mark  
9 (having a time length of 11T) and an 11T space portion  
10 (inter-mark portion having a time length of 11T) is  
11 overwritt n in such a manner that the 3T mark is erased in

12 an erase ratio of 25 dB or higher.

1 11. A rewritable optical recording medium according  
2 to claim 7, wherein said phase-change recording layer is  
3 a film having a thickness selected from the range of 10  
4 through 30 nm.

1 12. A rewritable optical recording medium according  
2 to claim 7, wherein said lower protective layer is a film  
3 having a thickness selected from the range of 50 through  
4 150 nm.

1 13. A rewritable optical recording medium according  
2 to claim 7, wherein said upper protective layer is a film  
3 having a thickness selected from the range of 30 through  
4 60 nm.

1 14. A rewritable optical recording medium according  
2 to claim 7, wherein said reflective layer is a film having  
3 a thickness selected from the range of 40 through 300 nm.

1 15. A rewritable optical recording medium according  
2 to claim 7, wherein said phase-change recording layer  
3 comprises one selected from the compositions represented  
4 by  $A^1_a A^2_b Ge_c (Sb_d Te_{1-d})_{1-a-b-c}$  (where  $0 < a \leq 0.1$ ,  $0 < b \leq 0.1$ ,  $c < b < a$ ,  
5  $0.02 < c \leq 0.2$ ,  $0.72 \leq d \leq 0.8$ , and  $A^1$  is at least one element  
6 selected from the group consisting of Zn, Pd, Pt, V, Nb, Ta,

7 Cr, Co, Si, Sn, Pb, Bi, O, N, S and rare earth metal elements,  
8 and A<sup>2</sup> is at least one element selected from the group  
9 consisting of Ga and In).

1 16. A rewritable optical recording medium according  
2 to claim 7, wherein said reflective layer comprises one  
3 selected from the group consisting of Al alloys and Ag  
4 alloys.

1 17. A rewritable optical recording medium according  
2 to claim 7, wherein said wobble groove has a wobble signal,  
3 whose frequency is modulated by  $\pm 1$  kHz according to ATIP  
4 (absolute time in pre-groove) information with a carrier  
5 frequency of approximately 22.05 kHz in terms of the  
6 frequency at the 1-times velocity of 1.2 m/s, said ATIP  
7 information including at least one of an optimum recording  
8 power  $Pw_0$ , an optimum erasure power  $Pe_0$ , an optimum bias power  
9  $Pd_0$  and a divided-pulse information in accordance with the  
10 recording linear velocity.

1 18. A rewritable optical recording medium according  
2 to claim 7, wherein said wobble groove has a wobble signal,  
3 whose frequency is modulated by  $\pm 1$  kHz according to on ATIP  
4 information with a carrier frequency of approximately 22.05  
5 kHz in terms of the frequency at the 1-times velocity, and  
6 also has clock marks arranged along said wobble groove at  
7 a repeating frequency in a range of from 2 to 8 times of

8 22.05 kHz.

1 19. A rewritable optical recording medium according  
2 to claim 7, wherein said wobble groove has a wobble signal,  
3 whose frequency is constant when the linear velocity is  
4 constant, and has address information and a synchronization  
5 pattern in terms of whether the wobble is modulated in phase  
6 or whether a specified position is devoid of wobble.

1 20. A method of recording EFM-modulated information  
2 in terms of different mark lengths on a rewritable  
3 disc-shaped optical recording medium having a phase-change  
4 recording layer by CLV (constant linear velocity) operation,  
5 said method being carried out in the following manner:

6 when an individual recorded mark has a time length  $nT$   
7 ( $T$  is the data reference clock period, and  $n$  is an integer  
8 within a range of from 3 to 11),

9 recording light of erasure power  $P_e$ , which is able to  
10 crystallize an amorphous-state portion, irradiates  
11 inter-mark portions,

12 for the recorded marks, the time length  $(n-j)T$  is  
13 divided into  $\alpha_1T$ ,  $\beta_1T$ ,  $\alpha_2T$ ,  $\beta_2T$ , ...,  $\alpha_mT$ ,  $\beta_mT$  (where  $m=n-$   
14  $1$  or  $m=n-2$ ) in this sequence so as to satisfy  $\sum_1(\alpha_i+\beta_i)=n-j$   
15 ( $j$  is a real number within a range of  $0.0 \leq j \leq 2.0$ ), and

16 the recording light of recording power  $P_w$  ( $P_w > P_e$ ),  
17 which is able to melt the recording layer within the time  
18 length  $\alpha_iT$  ( $1 \leq i \leq m$ ), irradiates the recording lay r, and

19 the recording light of bias power  $P_b$  ( $0 < P_b \leq 0.5 P_e$ ) within  
20 the time length  $\beta_i T$  ( $1 \leq i \leq m$ ) the recording layer to  
21 overwrite; and

22 when a linear velocity within a range of 1.2 m/s to  
23 1.4 m/s is the reference velocity (1-times velocity) and  
24 231 nsec (ns) is a reference clock period,

25 (1) for the 4-times velocity,  $\alpha_1 =$  from 0.3 to 1.5,  
26  $\alpha_i =$  from 0.2 to 0.7 ( $2 \leq i \leq m$ ),  $\alpha_i + \beta_{i-1} =$  from 1 to  
27 1.5 ( $3 \leq i \leq m$ ),

28 (2) for the 1- or the 2-times velocity,  $\alpha_1 =$  from 0.05  
29 to 1.0,  $\alpha_i =$  from 0.05 to 0.5 ( $2 \leq i \leq m$ ),  $\alpha_i + \beta_{i-1} =$   
30 from 1 to 1.5 ( $3 \leq i \leq m$ ), and

31 (3) for any of 6-, 8-, 10- and 12-times velocities,  
32  $\alpha_1 =$  from 0.3 to 2,  $\alpha_i =$  from 0.3 to 1 ( $2 \leq i \leq m$ ),  
33  $\alpha_i + \beta_{i-1} =$  from 1 to 1.5 ( $3 \leq i \leq m$ ).

1 21. A recording method according to claim 20, wherein  
2 for any of the described linear velocity in use,

3  $m$  is constant,

4  $\alpha_1 =$  approximately 1,  $\alpha_i =$  from 0.3 to 0.6 (where  $i$  is  
5 an integer within a range of from 2 to  $m$ ), and

6  $\alpha_i + \beta_{i-1}$  is constant (where  $i$  is an integer within a range of  
7 from 3 to  $m$ ), and

8  $\alpha_i$  is monotonically reduced for the lower linear  
9 velocity (where  $i$  is an integer within a range of from 2  
10 to  $m$ ).

1           22. A recording method according to claim 20, wherein  
2 for any of the described linear velocity in use,  
3           m is constant, and  
4           each of  $\alpha_i T$ ,  $\alpha_i T$ , and  $\alpha_i + \beta_{i-1}$  is constant (where i is  
5 an integer within a range of from 3 to m).

1           23. A recording method according to claim 21, wherein  
2 for any of the described linear velocity in use,  
3           m is constant, and  
4            $\alpha_i + \beta_{i-1} =$  approximately 1 for every i (where i is an  
5 integer within a range of from 2 to m).

1           24. A recording method according to claim 23, wherein  
2  $\alpha_i / \alpha_1 =$  from 0.3 to 0.7 (where i is an integer within a range  
3 of from 2 to m).

1           25. A recording method according to claim 20, wherein  
2 for any of the described linear velocity in use,  
3            $\beta_m =$  from 0 to 1.5, and  
4            $\beta_m$  is constant for every linear velocity, or is  
5 increased more for the lower linear velocity.

1           26. A recording method according to claim 20, wherein  
2 for any of the described linear velocity in use, each of  
3  $\alpha_i T$  ( $1 \leq i \leq m$ ) and  $\beta_i T$  ( $1 \leq i \leq m-1$ ) is 10 ns or more.

1           27. A method of recording various mark and inter-

2 mark lengths in terms of EFM-modulated information on a  
3 rewritable disc-shaped optical recording medium having a  
4 predetermined recording area by CAV (constant angular  
5 velocity) operation, in which the recording medium is  
6 rotated at a constant angular velocity, said method being  
7 carried out in the following manner:

8 when a linear velocity within a range of from 1.2 m/s  
9 to 1.4 m/s is a reference velocity (1-times velocity), the  
10 disc-shaped optical recording medium is rotated in a way  
11 that a linear velocity at an outermost periphery of the  
12 recording area is as high as 10 times of the reference  
13 velocity,

14 if a time length of an individual recorded mark is  $nT$   
15 ( $T$  is a data reference clock period varying according to  
16 its radial position in a way that a product  $VT$  ( $V$  is a linear  
17 velocity in the radial position) is constant, and  $n$  is an  
18 integer within a range of from 3 to 11),

19 recording light of erasure power  $P_e$ , which is able to  
20 crystallize an amorphous-state portion, irradiates  
21 inter-mark portions,

22 for the recorded marks, the time length  $(n-j)T$  is  
23 divided into  $\alpha_1T, \beta_1T, \alpha_2T, \beta_2T, \dots, \alpha_mT, \beta_mT$  (where  $m=n-$   
24  $1, \alpha_i =$  from 0.75 to 1.25,  $\alpha_i =$  from 0.25 to 0.75 ( $2 \leq i \leq m$ ),  
25  $\alpha_i + \beta_{i-1} =$  from 1 to 1.5 ( $3 \leq i \leq m$ )) in this sequence so as to  
26 satisfy  $\sum_1(\alpha_i + \beta_i) = n - j$  ( $j$  is a real number within a range of  
27  $0.0 \leq j \leq 2.0$ ),

28 within the time length  $\alpha_iT$  ( $1 \leq i \leq m$ ), the recording



29 light, whose record power  $P_w$  ( $P_w > P_e$ ) is enough to melt said  
30 recording layer, irradiates the recording layer, and within  
31 the time length  $\beta_i T$  ( $1 \leq i \leq m$ ), the recording light of bias  
32 power  $P_b$  ( $0 < P_b \leq 0.5 P_e$ ) irradiates the recording layer, and  
33 each of  $\alpha_i$  and  $\alpha_i + \beta_{i-1}$  ( $i =$  from 3 to  $m$ ) is constant for  
34 any radial position, and  $\alpha_i$  ( $i =$  from 3 to  $m$ ) is reduced  
35 monotonically for the radially inner position.

1 28. A method of recording various mark and inter-  
2 mark lengths in terms of EFM-modulated information on a  
3 rewritable disc-shaped optical recording medium having a  
4 predetermined recording area by CAV (constant angular  
5 velocity) operation, in which the recording medium is  
6 rotated at a constant angular velocity, said method being  
7 carried out in the following manner:

8 when a linear velocity within a range of from 1.2 m/s  
9 to 1.4 m/s is a reference velocity (1-times velocity), the  
10 disc-shaped optical recording medium is rotated in a way  
11 that a linear velocity at an outermost periphery of the  
12 recording area is as high as 10 times of the reference  
13 velocity,

14 if a time length of an individual recorded mark is  $nT$   
15 ( $T$  is a data reference clock period varying according to  
16 its radial position in a way that a product  $VT$  ( $V$  is a linear  
17 velocity in the radial position is constant, and  $n$  is an  
18 integer within a range of from 3 to 11),

19 recording light of erasure power  $P_e$ , which is able to

20 crystallize an amorphous-state portion, irradiates  
21 inter-mark portions,

22 for the recorded marks, the time length  $(n-j)T$  is  
23 divided into  $\alpha_1T, \beta_1T, \alpha_2T, \beta_2T, \dots, \alpha_mT, \beta_mT$  (where  $m=n-$   
24  $1, \alpha_i/\alpha_1 =$  from 0.3 to 0.7 ( $i$  is an integer within a range  
25 of from 2 to  $m$ ),  $\alpha_i+\beta_{i-1} =$  approximately 1 ( $3 \leq i \leq m$ )) in this  
26 sequence so as to satisfy  $\Sigma_1(\alpha_i+\beta_i)=n-j$  ( $j$  is a real number  
27 within a range of  $0.0 \leq j \leq 2.0$ ),

28 within the time length  $\alpha_iT$  ( $1 \leq i \leq m$ ), the recording  
29 light, whose record power  $P_w$  ( $P_w > P_e$ ) is enough to melt said  
30 recording layer, irradiates the recording layer, and within  
31 the time length  $\beta_iT$  ( $1 \leq i \leq m$ ), the recording light of bias  
32 power  $P_b$  ( $0 < P_b \leq 0.5P_e$ ) irradiates the recording layer, and  
33 each of  $\alpha_iT$  ( $i =$  from 2 to  $m$ ) and  $\alpha_i+\beta_{i-1}$  ( $i =$  from 3 to  
34  $m$ ) is constant for any radial position.

1 29. A recording method according to claim 27 or 28,  
2 wherein said recording area is divided into a plurality of  
3 virtual zones for every radial position,  $\beta_m =$  from 0 to 1.5,  
4 and  $\beta_m$  is monotonically increased for the radially inner  
5 zone.

1 30. A recording method according to claim 27 or 29,  
2 wherein said rewritable disc-shaped optical recording  
3 medium is a rewritable compact disc (CD-RW) in which at least  
4 an radius ranging from 23 to 58 mm is defined as said  
5 recording area.

1           31. A recording method according to claim 27 or 28,  
2 wherein each of  $\alpha_i T$  ( $1 \leq i \leq m$ ) and  $\beta_i T$  ( $1 \leq i \leq m$ ) is 10 ns or  
3 more for any radial position.

1           32. A recording method according to claim 27 or 31,  
2 wherein for any linear velocity in use, a value of each of  
3  $P_b$ ,  $P_w$ , and  $P_e/P_w$  is substantially constant.

1           33. A recording method according to claim 27 or 28,  
2 wherein

3           said rewritable disc-shaped optical recording medium  
4 has on a substrate a wobble groove having a wobble signal  
5 whose frequency is modulated by a starrering of  $\pm 1$  kHz  
6 according to ATIP (absolute time in pre-groove) information  
7 with a carrier frequency of approximately 22.05 kHz in terms  
8 of the frequency at the 1-times velocity,

9           said carrier frequency is detected while said  
10 rewritable disc-shaped optical recording medium is rotated  
11 at a constant angular velocity, and a data reference clock  
12 according to a disc radius is obtained by multiplying the  
13 detected frequency with 196, and

14           an ATIP (abosolute time in pre-groove) signal, which  
15 is the ATIP information, is detected, and a data reference  
16 clock, which is in synchronism with a synchronization  
17 pattern in the detected ATIP signal and a disc rotation,  
18 is obtained.

1           34. A recording method according claim 27 or 28,  
2 wherein

3           said rewritable disc-shaped optical recording medium  
4 has on a substrate a wobble groove that has a wobble signal,  
5 whose frequency is modulated by  $\pm 1$  kHz according to ATIP  
6 information with a carrier frequency of approximately 22.  
7 05 kHz in terms of the frequency at the 1-times velocity,  
8 and also clock marks arranged along the groove at a repeating  
9 frequency in a range of from 2 to 8 times of 22.05 kHz, and  
10          the individual clock mark is detected while said  
11 rewritable disc-shaped optical recording medium is rotated  
12 at a constant angular velocity, and a data reference clock  
13 is obtained by multiplying said repeating frequency of the  
14 clock mark with a predetermined multiplier.

1           35. A recording method according to claim 27 or 28,  
2 wherein

3           said wobble groove has a wobble signal, whose carrier  
4 frequency is constant when the linear velocity is constant,  
5 and also has address information and a synchronization  
6 pattern in terms of whether the wobble is modulated in phase  
7 or whether a specified position is devoid of wobble, and  
8          said carrier frequency is detected while said  
9 rewritable disc-shaped optical recording medium is rotated  
10 at a constant angular velocity, and a data reference clock  
11 is obtained by multiplying the detected frequency with a

12 predetermined multiplier.

1           36. A recording method according to claim 27 or 28,  
2 wherein  
3           said rewritable disc-shaped optical recording medium  
4 has absolute time information in terms of a sub-code Q  
5 channel signal recorded previously in the entire recording  
6 area as an EFM-modulated signal, and  
7           said EFM-modulated signal is detected while said  
8 rewritable disc-shaped optical recording medium is rotated  
9 at a constant angular velocity, and a data reference lock  
10 and address information are obtained from said EFM-  
11 modulated signal.

1           37. A recording method according to claim 27 or 28,  
2 wherein  
3           said rewritable disc-shaped optical recording medium  
4 has a block data structure according to CD-ROM  
5 specifications recorded previously in the entire recording  
6 area as EFM-modulated signal, and  
7           said EFM-modulated signal is detected while said  
8 rewritable disc-shaped optical recording medium is rotated  
9 at a constant angular velocity, and a data reference clock  
10 and address information are obtained from the detected  
11 EFM-modulated signal.

1           38. An optical disc recording/retrieving apparatus

2 comprising:

3 a motor for rotating a disc, which has a spiral groove  
4 with wobble which carrier frequency is constant in space  
5 frequency and meandering according to a signal modulated  
6 with a constant carrier frequency  $f_{L0}$  and address information  
7 and also has a recording layer, at a constant angular  
8 velocity with a center of the disc being an axis of rotation,  
9 the disc having address information identifying each  
10 recording data block, which is a unit of recording  
11 information located at a specified position in the spiral  
12 groove, and a synchronization pattern identifying a head  
13 position of the recording data block;

14 an optical pick-up for generating a focused laser beam  
15 irradiating the disc for recording/retrieving;

16 a linear motor for moving said optical pick-up  
17 radially of the disc to a given address;

18 a focus servo circuit for focusing the focused laser  
19 beam on the recording layer;

20 a groove tracking servo circuit for scanning the  
21 spiral groove by the focused laser beam;

22 a detector and decoder circuit for detecting and  
23 decoding a carrier frequency  $f_{A0}$ , address information and  
24 block synchronization signal from the meandering groove  
25 geometry;

26 a data-sequence generation circuit for generating a  
27 recording data sequence, which is modulated in terms of mark  
28 length modulation, in synchronism with a data reference

29 clock T which has a frequency  $f_{d0}$  and a start position of  
30 the recording block;

31 a laser-power modulation circuit for modulating a  
32 recording laser power in accordance with the recording data  
33 sequence;

34 a reference signal generator for generating a data  
35 reference clock T which varies in reverse proportion to a  
36 radius position when the focused laser beam is moved  
37 radially of the disc to a given address recording block;  
38 and

39 a data-sequence synchronization circuit for  
40 synchronizing a data sequence, which is to be written in  
41 the given recording block, with the start position of the  
42 recording block by comparing in phase between a reference  
43 signal  $f_{R0}$ , which is obtained by dividing the data reference  
44 clock at a particular radius by N (N is an integer), and  
45 the carrier frequency  $f_{A0}$ , which is detected at the given  
46 address from the meandering groove geometry, and also making  
47 a fine adjustment of r.p.m. (revolutions per minute) of the  
48 disc so as to satisfy a relation  $f_{d0} = N \cdot f_{A0}$ .

1 39. An optical disc recording/retrieving apparatus  
2 according to claim 38, wherein the frequency  $f_{d0}$  of the  
3 reference clock T at a particular address is varied  
4 according to the radius so as to satisfy a relation:

$$5 \quad f_{d0} = f_{ref} + (R - R_{ref}) / \Delta R$$

6 where  $f_{ref}$  is the frequency of a data reference clock  $T_{ref}$

7 for a reference radius  $R_{ref}$  at the head or tail of the  
8 recording area of the optical disc,  $\Delta R$  is a radial width  
9 of the recording medium from an innermost periphery to an  
10 outermost periphery, and  $R$  is a radius calculated from a  
11 given address at which object data is to be recorded.

1 40. An optical disc recording/retrieving apparatus  
2 according to claim 38, wherein within a range in which r.p.m.  
3 of the disc is adjusted is within  $\pm 0.01 \omega_0$  with respect to  
4 a reference r.p.m.  $\omega_0$ .

1 41. An optical disc recording/retrieving apparatus  
2 according to claim 38, wherein the carrier frequency  $f_{L_0}$  of  
3 the flowchart groove geometry is 22.05 kHz, the address  
4 information is an ATIP (absolute time in pre-groove) signal  
5 whose frequency is modulated by  $\pm 1$  kHz with the carrier  
6 frequency  $f_{L_0}$ , and  $\omega_0$  is within a range of from 1900 to 2200  
7 r.p.m.

1 42. An optical disc recording/retrieving medium  
2 wherein recording of data to an information area is made  
3 at a constant angular velocity, irrespective of the radial  
4 position where the recording takes place.

1 43. An optical disc recording/retrieving method  
2 wherein recording and retrieving to and from an information  
3 area are made each at a constant angular velocity.



1           44. An optical disc recording/retrieving method  
2 wherein recording and retrieving to and from an information  
3 area are made at the same angular velocity.

1           45. A rewritable optical recording medium according  
2 to claim 1 or 2, wherein

3           an application area includes an application program  
4 area occupying a continuous specified part of the  
5 application area and storing a predetermined application  
6 program, and a user data area which occupies the remaining  
7 portion of the application area and in which the user data  
8 relating to at least the application program is adapted to  
9 be recorded; and

10           retrieving of the application program and recording  
11 of the user data relating to the application program are  
12 made each at a constant angular velocity.

1           46. A rewritable optical recording medium according  
2 to claim 45, wherein the application program and the user  
3 data are recorded in fixed-length packet units each having  
4 a common file management structure for both the application  
5 program and the user data.

1           47. A recording/retrieving apparatus for performing  
2 recording and retrieving on a rewritable optical recording  
3 medium having an application ar a that includes an

4 application program area occupying a continuous specified  
5 part of the application area and storing a predetermined  
6 application program, and a user data area which occupies  
7 the remaining portion of the application area and in which  
8 user data relating to at least the application program is  
9 adapted to be recorded, the application program and the user  
10 data being recorded in fixed-length packet units each having  
11 a common file management structure for both the application  
12 program and the user data, and retrieving of the application  
13 program and recording of the user data relating to the  
14 application program being made each at a constant angular  
15 velocity (CAV), said apparatus comprising:

16 program executing means for executing the application  
17 program content by having access to the specified part of  
18 the application program in the rewritable optical recording  
19 medium to retrieve the application program data with keeping  
20 the medium, which is in the form of a disc, in CAV rotation  
21 at a first predetermined angular velocity;

22 information input means for inputting necessary  
23 information according to the application program to be  
24 executed by said program executing means; and

25 recording means for having access to the user data area  
26 with keeping the disc in CAV rotation at a second  
27 predetermined angular velocity and for recording in the user  
28 data area the necessary information, which is inputted by  
29 said information input means, as user data.

1           48. A recording/retrieving apparatus according to  
2 claim 47, further comprising information input offer means  
3 for retrieving a predetermined demonstration, during the  
4 execution of the application program, to offer whether the  
5 user should make information input in response to the  
6 demonstration.